Method for the Production of Surfaces Including Device for Execution of the Method And the Surfaces and also Their Use

The invention relates to a method for the production of a surface for an object according to the features disclosed in the disclosure part of Patent Claim 1. Furthermore the invention relates to a device for execution of the method as well as to the surface itself and its use.

From De 35 24 653 C2, providing the surfaces in the form of embossed, biaxially laid out foils which form an apertured grid-like cloth as an article with openings and webs is already known, whereby elevated areas are rounded off and deformed each as a sort of projection, which leads to a web component part incorporated within the cloth structure. The manufacture of apertured netted cloths by embossment of a foil of thermoplastic polymers using such a known solution leads to improved properties regarding its grip and with corresponding subsequent treatment leads to reduction of undesirable shiny effects of the material.

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Furthermore, from EP 0 772 514 B1 are known self-cleaning surfaces of articles which have a synthetic surface structure consisting of projections and recesses of a sort whereby the spacing between the projections is in the range of 5 to 200 micrometers and the height of the projections is in the range of 5 to 100 micrometers. Then in addition at least the projecting parts are to consist of hydrophobic polymers or else materials which are made permanently hydrophobic, and the projections can be loosened and peeled off neither by water nor by water with detergents added thereto.

The known solution shows a surface with these projections for the repelling of contaminants, whereby a simulated lotus-petal structure is synthetically constructed, from which it is known that it is not contaminated because of the capacity of the structure for self-cleaning, and even commercial adhesives are removable from the biological structure. Despite remarkable results with regard to a self-cleaning effect, such known surfaces can be used only in a limited manner, since either the range of materials which can be used in the production is greatly limited or the surface must be treated by

further processing for the purpose of making it hydrophobic, which is costly. Also the known surface can be produced only at high cost while incurring considerable complications. For production of the known surface, coating

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methods or shaping methods are provided using high-grade mesh screens, which are costly and difficult to produce. Also in practice it has been shown that such synthetically produced surfaces with 'lotus effect' often do not produce the desired results.

Finally, from PCT/WO 93/01047 is known a surface consisting of a deeply embossed, thermoplastic film. This film surface includes a plurality of macroscopic cells as first projections, which are connected by the areas extending between these adjacent macroscopic cells, whereby the macroscopic cells have a depth of 0.635 to 3.8 mm and in addition to the thermoplastic film incorporate a plurality of microscopic indentations, which construct a fortuitously distributed sandblast pattern on the film, with a spacing between 1.25 and 7.35 micrometers. These microscopic indentations form a second type of projection, which projections have an opposite orientation to the projections of the first type, so that the projections are arranged according to types separated from one another on opposite sides of the surface. Such known surfaces, usually in the form of polyolefin

foils, such as surfaces of polyethylene, are particularly used in those cases, with projections of raised area extending between them, wherein particular requirements are set on such cloth material relating to esthetic or visual

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sense-perceptions, in other words for use in the field of linings of clothing or else hygienic or sanitary areas, and have no dirt-repelling properties, so that a self-cleaning effect is not demonstrable in this case.

From EP 0 933 388 A2 is known a structured surface with hydrophobic and/or oil-resistant properties with low surface charges. The known surfaces have high boundary or rim angles with water and are cleaned with water only with difficulty and therefore include a self-cleaning effect. In order to attain this a synthetically producible base structure is provided with two different types of projections, whereby a type of smaller projections are mounted on a superstructure, in the form of projections of large dimensions, which are mounted and are in direct contact adjacent to one another. For the production of the known projections and the superstructure as an another type of projections these projections either simultaneously or in sequence are mechanically impressed or embossed into the surface material, etched in by lithographic method or obtained by shaping processing by means of applied or casting technology. With the mechanical imprinting or embossing

method it is worked from the reverse side forward on the surface, which then on its opposite side shapes out the aforementioned two types of projections. With etching of the structure into the surface material the damage resulting from the etching medium is to be calculated at least in part. With the surface shaping method first of all the relevant projection structure is applied on the surface by means of an application roll applied to the surface material. The last method is expensive and cost-intensive and does not guarantee that, dependent upon the stress, the structure mounted thereon in this manner not again become detached from the base material. The known casting, imprinting or embossing, etching and surface application methods are therefore not suitable in large-scale measure to make available the production of large quantities of structured surfaces.

Starting from this state of the art the object of the invention is to further improve the known method for the production of synthetic surfaces having two different types of projections, so that they can be realized at lower cost, and reasonably large volumes of surfaces can be made available by use of

finishing techniques, and still the surface particularly inheres a very good repelling capacity for contaminants. Such an object discloses a method for the production of such surfaces having the features disclosed in Claim 1 as well as a device for execution of the method with the features disclosed in Claim 2. Another object of the invention is the surface produced according to the method and the device, as well as its use.

Due to the fact that according to the characterizing part of Claim 1 the surface is produced continuously by means of a structure and shaping roll as foil or strip material, which is provided with recesses corresponding to the first and second types of projections, into which the synthetically producible base structure enters for its shaping, a shaping method is realized in which the projections of the first and second type are depicted in reverse in the recesses of the structure roll and the surface is obtained in that manner. With the resulting method, shaping out by means of a structure and shaping roll having recesses to shape out the convex projections, the dirt-repelling surface can be made available uniformly and cost effectively in large quantities by use of manufactuering technology.

Preferably the structure and shaping roll is configured so that, particularly with use of a backing roll, a shaping gap is formed, through which the synthetic material passes. Dependent upon the width and the diameter of the structure and shaping roll, the desired surfaces can be produced in any desired length and width and insofar as the backing roll is configured as a shaping roll with a structure comparable to that of the structure and shaping roll, the desired microscopic surface structure can be produced on both sides. The synthetically producible base structure then penetrates into the surface of the structure and shaping roll for its shaping and then immediately leaves the structure and shaping roll as finished product. By the use of hydrophilic plastic material for the base structure therefore an improved dirt-repelling degree can be attained than with the known hydrophilic and/or oil-resistant structures.

In the case of the device according to the invention for execution of the method as in Claim 1, the recesses for the structure and shaping roll are obtained by a sandblast method, in which using a stream of material of

larger diameter and another stream of smaller diameter the recesses for the first type and the second type of projections are formed, or in which the stream of material is provided on its granular surface with further projections which form the recesses for the projections of the first type. The resulting sandblast methods are very cost effective and offer the required precision for the subsequent projection structures of the structured surface. The synthetic base structure which is obtained finds its equivalents in nature, for

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example in the leaves of the nasturtium. Earlier research has shown that the nasturtium has an extremely fine ultrastructure regarding its leaves, with structural elements in the form of projections which are shorter than 12 micrometers. Such surface structures, which were not known in detail (cf. EP 0 772 514 B1, column 1, lines 4ff), were assumed to not be synthetically producible and considered in relation to their mechanical resistance capacity as extremely sensitive and consequently as unsuitable in terms of practical importance. On the other hand it was seen in technical terms as simple to understand the lotus leaf structure as the natural pattern. It is consequently surprising for the expert in the art that on the one hand the extremely fine ultrastructure of the biological prototype of the nasturtium has succeeded as ascertainable and on the other hand to complete the synthetic construction thereof and to develop said construction further into a product which on the one hand has a very good dirt-repelling property and on the other hand unexpectedly also brings with it the mechanical stability required for such a product.

The basic structure of the surface is indicated by a smooth lotus leaf

structure, on which the projections are arranged protruding outward in such a manner that the basic structure is not flat, but rather convex projections

have been constructed thereon, on which in turn the smaller projections are mounted as integral component parts. Such structured surfaces are also indicated in terms of the foils known from PCT/WO 93/01047 and DE 35 24 653 C2. Due to the fact that the first type of projections stands away each as a convex curve from the base structure of the surface, then, as opposed to a smooth structure, a considerably enlarged surface of the mounting of the second type of projections is made available. Despite the doubts inherent in technology, such surfaces according to the invention can be constructed in good form at low cost in large quantities of surface, whereby the thus produced surface is mechanically stable, even under corresponding high stresses applied to the surface or the base structure. Due to the fact that the projections of the first type are arranged in contact with one another in the case of the surface of the invention in such a manner that the adjacent projections of the first type engage on one another in close contact, and they also are cut down clearly smaller than the known orders of magnitude of the dimensions in the case of the lotus leaf solution found in EP 0772 514 B1, if the occasion arises then also an improved repelling behavior to repel

polluting particles is provided, since these features can be incorporated between the projections on the basic structure without further steps.

Preferably polyvinyl chloride, polyterephthalate, polymethyl methacrylate or polyamide are used as hydrophilic synthetic materials for the base structure.

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Due to the fact that with one preferred embodiment of the surface according to the invention the second type of projections stands out gudgeon-like from the first type of projections and that the relevant projection of the second type is in terms of height shorter than 5 micrometers or between 1.5 and micrometers, and that the spacing between the projections of the second type is likewise smaller than 5 micrometers, preferably 1 to 3 micrometers, a surface of microscopic structure can be disclosed which if required is suitable for use with adhesive closings wherein hook elements of two closing parts cooperate with one another or hook elements of a closing part cooperate with loop material of another part.

The surface according to the invention can be used particularly for articles in order to prevent their unwanted contamination, and also the aforementioned projections of the first type are arranged in close contact adjacent to one another so that contamination particles of average dimensions impacting on

the surface cannot come in contact with the surface between the projections. Furthermore, the surface can be subjected to a current, for example an air or water current, so that in the main direction of the current, turbulence occurs because of the projections, whereby surprisingly there occurs a lowering of the wall friction. Such surfaces having rib structures can be used for this purpose in the state of the art (cf. for example EP 0 846 617 A2).

Hereinafter the surface is to be described in greater detail relative to one embodiment as shown in the drawing, which also shows more detail for its production and its use.

Shown in the drawing in principle but not in actual dimensions are the following :

Fig. 1 : a cross section of the surface in a side view;

Fig. 2 : a planar view of the surface arrangement as in Fig. 1;

Fig. 3 : a perspective view of the structure and shaping roll for production of the surface as in Figs. 1 and 2 with an enlarged section relating to its recessed structure.

The surface shown in Figs. 1 and 2 for an object which is not to be described in greater detail incorporates a synthetically produced base structure 10, wherein at some spacing therefrom a second type of projections 16 protrudes from the first type of projections adjacent and engaging with one another in close contact, whereby the second type of projections 16 are limited from the first type of projections 12 by areas 14, Fig. 2. The resulting first type of projections 12 is configured to be convexly elevated as compared with the basic structure 10, and, as shown in Fig. 1, forms closed off mounds in and of itself. From observation of Figs. 1 and 2 it is to be noted that it has to do in the case of the cited projections with microscopic structures and accordingly the representation greatly enlarges the effective conditions being represented and also greatly simplifies the picture. Particularly the spaces between the projections are shown only in principle, in order to clarify the sense of the invention. As Figs. 1 and 2 further show, projections 16 of the second type are arranged on the first type of projections 12 and consequently, on the side turned away from the article, form integral component parts of projections 12, with which they are integrally connected.

Basic structure 10 is formed of a synthetic material, preferably of a hydrophilic plastic material, such as polyvinyl chloride, polyterephthalate,

polymethyl methacrylate or polyamide. As Figs.1 and 2 further show, the second type of projections stand projecting gudgeon-like beyond the first type of projections 12, whereby the relevant projection 16 of the second type is of a height shorter than 5 micrometers, preferably between 1.5 and 3 micrometers, whereby the spacing between projections 16 of the second type likewise is smaller than 5 micrometers, preferably 1 to 3 micrometers. The respective height is measured from foot to apex point of each projection 16 and the spacing of projections 16 from one another is the average spacing between the exterior peripheries of projections 16. As can be seen particularly from Fig. 2, the relevant convexly configured projection 12 of the first type has a surface on the base structure 10 of between 20 and 300 micrometers^2 and the height between base structure 10 and the apex of the relevant projection 12 of the first type is between 10 and 50 micrometers. The limitable areas 14 form a sort of cluster structure and said areas 14 are in contact with one another essentially directly along connection lines 18.

A production method using a shaping or structure roll 20 is used for the production of the aforementioned surface, as is shown in Fig. 3 in its principle construction. Using grooved roll 20 it is possible to continuously produce the surface out of synthetic material as foil or strip material,

whereby said shaping or structure roll 20 is provided with recesses 22 and 24 corresponding to the first and second types of projections 12, 16, into which the synthetically producible basic structure 10 penetrates in order to be shaped. In the direction of viewing seen in Fig. 3, at the top left is shown an enlarged section of the surface of shaping or structure roll 20, which shows the corresponding recesses 22, 24. Preferably a sandblast method is used to produce the resulting recess structure for shaping or structure roll 20, whereby with these sandblasting granules of enlarged diameter greater concave recesses 24 are formed, which thereafter serve for the production of the first type of projections 12 and with a blast material of smaller diameter then within recesses 24 the other recesses 22 can be shaped, which thereafter serve for the production of the second projections 16. Instead of blasting material with various dimensions it is also possible to use also only blasting material which on its granular surface is provided with further projecting components, which form the recesses 22 for projections 16 of the second type. The resulting sandblasting methods are very cost effective and offer the required precision for the subsequent projection structures for the surface of the invention.

Shaping or structure roll 20 can be configured as a hollow cylinder and particularly can be heated, insofar as the plastic material to be treated makes this necessary. When another not shown support roll is incorporated, shaping or structure roll 20 then forms a profiling gap through which the plastic material passes. Dependent upon the width and diameter of shaping or structure roll 20 the desired surfaces can be produced in desired lengths and widths.

The surface thus produced can be used particularly in order to prevent the contamination of the covered articles, and projections 16 of the second type are arranged standing closely adjacent to one another, so that the free spaces between these projections 16 are smaller than the average dimensions of the contamination particles impinging on the surface.

The materials provided for the production of the surface for an article can be formed of regrowth-capable raw materials and are preferably biodegradable. The final regulation in this case is the DIN V 54900 and polyactides have been shown to be particularly suitable for the surface material.